Gravity waves produced by potential vorticity anomalies

François Lott, Riwal Plougonven, Jacques Vanneste

Francois Lott (LMD)

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Francois Lott, R. Plougonven (LMD, Paris)
J. Vanneste (University of Edimburg)

The gravity waves (GWs) produced by potential vorticity (PV) anomalies in a vertical wind shear are evaluated for an unbounded rotating stratified flow. In this set-up, the disturbances have two inertial layers, one on each side of the PV anomaly that produces them. Between these layers the disturbance is well predicted by the quasi-geostrophic theory, beyond these layers it corresponds to propagating GWs.

This GW signal is predicted analytically using a Green's function method. The Green's functions used belong to the continuum of solutions of the non-geostrophic Eady problem of baroclinic instability. We find that the non-dimensional EP-flux of the GWs in the far field is approximately exp(-pi N/Uz)/8, where N is the Brunt-Vaisala frequency and Uz the wind shear. Between the two inertial layers the EP-flux is twice that outside of them,which means that substantial wave-flow interactions occur in the inertial layers. This formula is found to be useful for a large range of PV distribution, is easy to translate in dimensional form and from the large scale flow characteristics. The case of a PV disturbance with amplitude 1PVU and depth 1km is then analysed. When this disturbance enters in the troposphere, the EP-fluxes are between 0.1mPa and 100mPa when the Richardson number J=N/Uz is between 1 and 10. These values compare with those observed in the low stratosphere, which suggests that we have identified a substantial GW source, and that this source can be parameterized in GCMs.

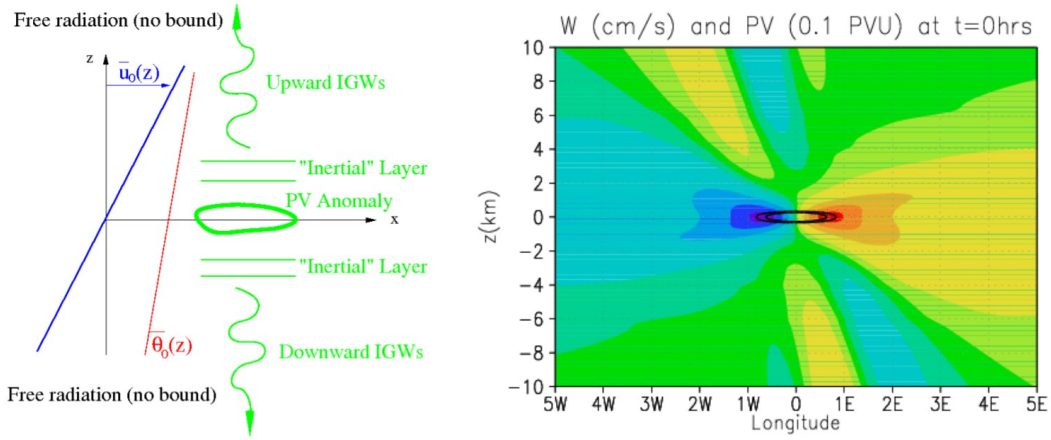

Figure 1: L'anomalie de tourbillon potentiel (en traits noirs) produit un champ de vitesse verticale, qui loins des niveaux critiques inertiels devient un champ d'ondes de gravité.

1. Lott F., R. Plougonven, and J. Vanneste, Gravity waves generated by sheared potential-vorticity anomalies, Journal of the Atmospheric Sciences, 67, 157-170, 2010. doi: 10.1175/2009JAS3134.1
2. Lott, F., R. Plougonven, and R. Vanneste, 2012: Gravity waves generated by sheared three dimensional potential vorticity anomalies,69, 2134–2151. doi: http://dx.doi.org/10.1175/JAS-D-11-0296.1